

## POWER-ASSISTED STEERING SYSTEM OR POWER STEERING SYSTEM

FIELD OF THE INVENTION

The present invention relates to a power-assisted steering system or power steering system.

5 BACKGROUND INFORMATION

In power-assisted steering systems or power steering systems having an electric motor, which drives a worm gear mechanism that includes a composite gear wheel, e.g., having a plastic ring gear, the composite gear wheel may ensure a high degree  
10 of running smoothness with high economic efficiency, when the worm gear mechanism has large dimensions and is paired with metallic wheels having a high degree of edge smoothness. Composite gear wheels are conventional.

15 PCT International Published Patent Application No. WO 01/44694 describes a composite gear wheel, which is suitable for a worm gear mechanism of a power-assisted steering system or power steering system, having a two-piece ring gear that is screwed onto a hub. The hub has an annular flange on one axial end.  
20 The ring gear is form-locked to the hub by a disk, which is positioned in the axial direction of the composite gear wheel, on the opposite side of the annular flange. Both the disk and the annular flange of the hub have an annular projection, which, in each instance, engages with an annular groove on the  
25 side faces of the ring gear in the axial direction of the composite gear wheel and secures the ring gear in the radial direction.

To transmit the torque from the ring gear to the hub or vice  
30 versa, threaded bolts are guided through the disk, the ring gear, and the annular flange of the hub. The individual component parts and, in particular, the threaded bolts are not

self-centering, which is why the power transmission in the composite gear wheel and the assembly sequence of the composite gear wheel are not optimized.

## 5 SUMMARY

Example embodiments of the present invention may provide a composite gear wheel for power-assisted steering systems or power steering systems having an electric motor that drives a worm gear mechanism, so that the assembly of the gear wheel  
10 may be simplified and the power transmission in the composite gear wheel may be uniform.

In power-assisted steering systems or power steering systems having an electric motor that drives a worm gear mechanism, a  
15 composite gear wheel may be provided having the features described herein.

Since the annular, axial projection of the disk has a depression in the axial direction and a keyed connection in  
20 the tangential direction is rendered possible at an axial side face of the ring gear by a projection and by a depression, a centering aid which may allow simple, rapid assembly of the composite gear wheel may be provided in the tangential direction between the disk and the ring gear. For example,  
25 when a plurality of depressions are provided, it may be possible to achieve uniform torque transmission between the hub, disk, and ring gear, distributed over the circumference of the disk.

30 The keyed connection between the disk and the ring gear may be provided by projections and depressions on the disk, and by complementary projections and depressions in the side face of the ring gear in, in each instance, the axial direction of the composite gear wheel. The depressions and projections form a  
35 drive-type toothed section in the tangential direction. It

may be provided that the projections and depressions are block-shaped and are positioned about the circumference of the disks and the ring gear, in that the depressions rectangularly pass through the originally annular, axial projection on the circumference of the disk in a radial direction. The depressions may also pass through the annular, axial projection, having curved edges. The disk may be formed in one piece with the hub or suitably fastened to the hub in a form-locked or force-locked manner. The ring gear may be axially fixed between two disks and fastened to the hub by them in a rotatably fixed manner. The shape, cross-sectional shape, and the inner and outer diameters of the second disk may be similar to or the same as those of the first disk. The second disk has an annular, axial projection, which is interrupted by one or more depressions and is directed toward an axial side face of the ring gear.

The shape and the number of depressions and projections on the second disk and the side face of the ring gear may be the same as on the first disk and on its complementary side face of the ring gear. They may be conically interlocking.

The second disk may be connected to the ring gear and/or to the first disk fastened to the hub, using rivets or threaded bolts or friction welding.

The arrangement of the composite gear wheel may be suitable for making the ring gear out of a thermoplastic or duroplastic synthetic material. The composite gear wheel may be capable of producing a low-noise gear unit of a power-steering system or power-assisted steering system of a vehicle, and, e.g., as a worm wheel of a steer-by-wire system.

Example embodiments of present invention are described in more detail below with reference to the appended Figures.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a longitudinal cross-sectional view of a composite gear wheel taken along line II-II illustrated in Fig. 2.

5

Fig. 2 illustrates a composite gear wheel in arrow direction I illustrated in Fig. 1.

Fig. 3 is an exploded view of a further composite gear wheel.

10

## DETAILED DESCRIPTION

Illustrated in the Figures is a composite gear wheel, as is used in a worm gear mechanism for power-assisted steering systems or power-steering systems, where the gear wheel is used as a worm wheel that engages with a worm or worm gear, in order to provide steering assistance or to produce the entire required steering force.

15

Figure 1 is a longitudinal cross-sectional view of a composite gear wheel 1 taken along line II-II illustrated in Fig. 2.

20

Composite gear wheel 1 includes: a cylindrical hub 3, on whose one axial end 14 a first disk 2 having a crimped cross-section is formed in one piece; of an annular ring gear 4; and a second disk 12. Ring gear 4 is made of a thermoplastic synthetic material. First and second disks 2, 12 terminate ring gear 4 in the axial direction and are pressed against it with the aid of six rivets 15, which pass through disks 2, 12 and ring gear 4. Hub 3 and first and second disks 2, 12 are made of metal.

25

30

On their outer circumferential edges, the two disks 2, 12 have an annular projection 5, 5' facing ring gear 4 in the axial direction. Annular projections 5, 5' are interrupted by depressions 6, 6', which have a rectangular cross-section when viewed in the radial direction of disks 2, 12 (cf. Fig. 3).

35

In the composite state of composite gear wheel 1, tooth-like projections 5, 5' formed in this manner extend into depressions 7, 7' on axial side faces 8, 8' of ring gear 4.

In this manner, a keyed connection with ring gear 4 is

5 produced in the radial and tangential directions of disks 2, 12. Depressions 7, 7' and projections 5, 5' may be formed comically with respect to each other, which may simplify the assembly of composite gear wheel 1. Depressions 6, 6' on disks 2, 12 are positioned at the same tangential distance 9  
10 from each other and form a drive-type toothed section 10, which points in the axial direction toward ring gear 4, at the outer circumferential edge of disks 2, 12. Instead of in a conically even manner, edges 11 of projections 5, 5' may also extend toward depressions 7, 7' in a conically curved manner.

15 As illustrated by Fig. 2 in a plan view of assembled gear wheel 1 in arrow direction I illustrated in Fig. 1, and as illustrated by Fig. 3 in an exploded view of a further assembled gear wheel 1, rivets 15 are positioned axially  
20 symmetrically with respect to each other in the radial direction in the vicinity of the hub and are mounted flush with the outer contour of disks 2, 12. Ring gear 4 has straight-cut teeth. Inner diameter 16 of ring gear 4 extends into the disk support, which means that elastic, radial and  
25 axial expansion of plastic ring gear 4 caused by, for example, water absorption or the effect of temperature may occur without acting on the connecting points of rivets 15.

In contrast to gear wheel 1 illustrated in Figures 1 and 2,  
30 gear wheel 1 illustrated in Figure 3 includes a hub 3, two disks 2, 12, and a ring gear 4, which means that hub 3 and disks 2, 12 represented separate component parts to be connected in a form-locked manner.